

UNCLASSIFIED

AD 410514

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

N-63-1-3

UNCLASSIFIED

CATALOGED BY DDC 410514
AS AD No. _____

410514

INVESTIGATION OF ULTRASONIC WELDING OF REFRACTORY METALS AND ALLOYS

July 1963

Prepared under Navy Bureau of Naval Weapons
Contract No. N0w 63-0125-c

Bimonthly Progress Report No. 5
16 April 1963 thorough 15 June 1963

RECEIVED
JUL 27 1963
TISIA B

AEROPROJECTS INCORPORATED
WEST CHESTER, PENNSYLVANIA

UNCLASSIFIED

UNCLASSIFIED

INVESTIGATION OF ULTRASONIC WELDING
OF REFRACTORY METALS AND ALLOYS

July 1963

Prepared under Navy Bureau of Naval Weapons
Contract No. NOW 63-0125-c

Bimonthly Progress Report No. 5
16 April 1963 through 15 June 1963

AEROPROJECTS INCORPORATED
West Chester, Pennsylvania

UNCLASSIFIED

INVESTIGATION OF ULTRASONIC WELDING
OF REFRACTORY METALS AND ALLOYS

ABSTRACT

The necessity for moving the experimental welder and instruments into a new area precluded continuation of actual welding studies during this period. The interruption of the experimental work provided time for the incorporation of modifications and improvements to the existing welding array, the necessity for which has become increasingly apparent during the course of the work.

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	11

INVESTIGATION OF ULTRASONIC WELDING
OF REFRACTORY METALS AND ALLOYS

A. Power Programming	1
B. Force Programming	1
C. Equipment Integration	1
Weldment Materials	2
Future Work	3

INVESTIGATION OF ULTRASONIC WELDING
OF REFRACTORY METALS AND ALLOYS

The power-force programming study of the welding behavior of 2024-T3 aluminum, AISI 304 stainless steel, and Inconel X, described in Progress Report No. 4, revealed several minor difficulties with the welding array and instrumentation which required correction prior to continuation of the program. The necessity of moving the welder and instruments into a new location provided a convenient time for these corrective measures to be taken.

A. Power Programming

The initial studies had indicated that the variation in power delivered to the transducer had not always followed the linear variation set out on the program pegboard. The incremental steps of power over the effective range of the program control have been made uniform by modification of the circuit of the program controller. The power input to the transducers may thus be divided into ten steps of equal magnitude throughout the power range used in the welding studies.

B. Force Programming

Two difficulties were observed in the force-measuring instrumentation. Information for recording the actual changing clamping force is provided by the signal from SR-4 strain gages mounted on the body of each hydraulic cylinder. A decrease in sensitivity of the output from the strain gages was observed during continued operation. Inspection of the gages revealed inadequate bonding to the cylinders. These gages were removed and replaced with securely bonded gages.

Pick-up of stray magnetic fields by the strain gage cables had disturbed the strain gage signals, necessitating a power-dependent correction factor. Cables have been shielded for use in magnetic fields to reduce magnetic pick-up.

C. Equipment Integration

The large number of recording and measuring instruments, with associated power supplies and interconnecting wiring, has made operation inconvenient. This unwieldy array of instrumentation has been integrated to provide greater accessibility and convenience of operation.

Weldment Materials

During this report period the following materials were received:

Material	Gage, Inch	Source
C-105 Columbium	0.015	Wah Chang
B-66 Columbium	0.005	Westinghouse
B-66 Columbium	0.015	Westinghouse
Tungsten	0.010	Fansteel
Tungsten	0.020	Fansteel
Tungsten	0.060	Fansteel
Tungsten	0.100	Fansteel

The powder metallurgy tungsten was produced under the Bureau of Naval Weapons Refractory Metal Sheet Program, Contract NOW 60-0621-c. This material was supplied to us by Fansteel Metallurgical Corporation at the request of the Bureau of Naval Weapons, for use in connection with the performance of Contract NOW 63-0125-c and AF 33(600)-43026*.

Identity of all test specimens shall be subject to control with regard to sheet number, position on sheet, final rolling direction, etc.

The material received is identified as follows:

Powder Metallurgy Tungsten

(Received from Fansteel Metallurgical Corporation)

Nominal Gage, (Inch)	Sheet Size (measured), (Inches)	Identification
0.010	17-11/16 x 25-3/4	Lot A 5467 Sheet Plate 3
0.010	18-3/16 x 26	Lot A 5467 Sheet Plate 2
0.020	18-1/2 x 30-1/8	Lot A 5467 Sheet Plate 3-1
0.060	21-1/2 x 29	Lot A 5467 Sheet Plate 19
0.100	18-15/16 x 33-1/2	Lot A 5467 Sheet Plate 101

* Letter (T. F. Kearns, Head, Metals Branch, Materials Division, Department of the Navy, Bureau of Naval Weapons to H. L. McKaig, Vice President, Aeroprojects Incorporated) dated 29 April 1963.

Additional tungsten and Mo-0.5 Ti alloy sheets are on order.

The materials received to date are adequate to start the next phase of investigative work involving the application of power-force programming techniques to the ultrasonic welding of refractory metals and alloys.

Future Work

Power-force programming will be applied to the welding of refractory metals. Experiments will be designed with the view of establishing PFP patterns for the production of high-quality ultrasonic welds.

DISTRIBUTION COPIES

<u>Number of Copies</u>		<u>Number of Copies</u>	
12 and 1 repro	Chief, Bureau of Naval Weapons Washington 25, D. C. Attention: DLI-31 RRMA-24 (6) PID-2 (1) NPR-531 (1) SP-27 (1) RMMP-23 (1) DLI-31 (2)	1	Commanding Officer Naval Ordnance Test Station China Lake, California Attn: Code 55
		1	U. S. Army Research Office 3045 Columbia Pike Arlington 4, Virginia Attn: Mr. A. L. Tarr
10	Armed Services Tech. Info. Agency Arlington Hall Station Arlington 12, Virginia Attn: Document Service Center (TICSCP)	1	Headquarters, Army Material Command Washington 25, D. C. Attn: AMCRD-RS-CM
2	Office of Technical Service Department of Commerce Washington 25, D. C.	1	Commanding Officer Watertown Arsenal Watertown, Massachusetts Attn: Mr. N. L. Reed, Ordnance Materials Research Office
1	Chief, Bureau of Ships Department of the Navy Attn: Code 634B Washington 25, D. C.	1	Commanding General Frankford Arsenal Philadelphia 37, Pennsylvania Attn: Mr. J. J. Power, Jr. (ORDBA-LMJ)
1	Commanding Officer Naval Ordnance Laboratory White Oak, Silver Spring Maryland Attn: Technical Library	1	Army Ballistic Missile Agency Redstone Arsenal Huntsville, Alabama Attn: Chief, Materials Branch Development Operations Division
1	Chief, Naval Research Laboratory Department of the Navy Washington 25, D. C. Attn: Mr. W. Pellini, Supt. Metallurgy Dept.	1	Commanding Officer Watertown Arsenal Laboratories Watertown 72, Massachusetts Attn: Mr. S. V. Arnold, Associate Director
1	Chief, Office of Naval Research Department of the Navy Washington 25, D. C. Attn: Metallurgy Section	1	Commanding Officer Army Rocket and Missile Agency Redstone Arsenal, Alabama Attn: Technical Library (ORDXR-OTC)
1	Commanding Officer Naval Air Engineering Center Philadelphia 12, Pennsylvania Attn: Metallurgy Division, AML		

DISTRIBUTION LIST (Continued)

1	Commanding Officer Army Chemical Corps Command Munitions Division Army Chemical Center, Maryland Attn: Mr. Joseph Trost	1	U. S. Atomic Energy Commission Attn: Technical Information Service Oak Ridge, Tennessee
1	Commanding Officer Engineering Res. & Dev. Lab. Department of the Army Fort Belvoir, Virginia Attn: Metallurgical Dept.	1	National Academy of Sciences 2101 Constitution Avenue, N. W. Washington 25, D. C. Attn: Dr. J. Lane, Metallurgist Materials Advisory Board
1	Commander Aeronautical Systems Division Attn: Metals & Ceramics Laboratory (ASRCM) Wright-Patterson Air Force Base, Ohio	3	Aerospace Industries Association Technical Services Division Shoreham Building Washington 5, D. C.
1	Commander Aeronautical Systems Division Attn: Applications Lab. (ASRCE) Wright-Patterson Air Force Base, Ohio	1	Welding Research Council of the Engineering Foundation 345 East 47th Street New York 17, New York
2	Commander Aeronautical Systems Division Attn: Manufacturing Technology Laboratory (ASRCT)	2	Battelle Memorial Institute Defense Metals Information Center Attn: Mr. C. S. DuMont 505 King Avenue Columbus 1, Ohio
3	Scientific & Technical Info. Facility National Aeronautics and Space Admin. Rep. (SAK/DL-419) P. O. Box 5700 Bethesda, Maryland	1	Battelle Memorial Institute 505 King Avenue Columbus 1, Ohio Attn: Mr. M. J. Rieppel Chief, Metals Joining Division
1	The Arnold Engineering Company P. O. Box C Marengo, Illinois Attn: Mr. Benjamin Falk	1	Armour Research Foundation Illinois Institute of Technology Metals Research Dept. 3350 S. Federal Street Chicago 16, Illinois Attn: Dr. W. Rostoker
1	Atomic Energy Commission Germantown, Maryland Attn: Mr. J. Simmons, Div. of Reactor Development	1	Rensselaer Polytechnic Institute Department of Metallurgical Eng. 110 Eight Street Troy, New York Attn: Dr. Earnest Nippes
2	Brookhaven National Laboratory Information and Publication Service Uptown, New York Attn: Miss Mary Weismann, Document Section		

DISTRIBUTION LIST (Continued)

1	Ohio State University Department of Welding Engineering Columbus, Ohio Attn: Prof. R. B. McCauley	1	North American Aviation, Inc. Los Angeles Division International Airport Los Angeles, California Attn: Mr. H. D. Mason, Engineering Section
1	Massachusetts Institute of Technology Metallurgy Department Cambridge 39, Massachusetts Attn: Dr. Clyde Adams	1	North American Aviation, Inc. Columbus Division 4310 N. 5th Avenue Columbus, Ohio Attn: Mr. Paul Maynard, Chief of Materials
3	Chemical Propulsion Information Agency The John Hopkins University Applied Physics Laboratory 8621 Georgia Avenue Silver Spring, Maryland	1	Westinghouse Electric Corporation Research Laboratories Beulah Road, Churchill Boro Pittsburgh 35, Pennsylvania Attn: Chief, Metals Joining Section
1	University of California Los Alamos Scientific Laboratory Los Alamos, New Mexico Attn: Mr. J. R. Taub, Group Leader	1	Gulton Industries, Inc. 212 Durham Avenue Metuchen, New Jersey Attn: Director, Research & Dev.
1	Pratt & Whitney Division United Aircraft Corporation Connecticut Aircraft Nuclear Engines Laboratory Middletown, Connecticut Attn: Mr. L. M. Raring, Chief Metallurgist	1	Circo Ultrasonic Corporation Attn: Mr. B. Carlin, Vice-President 51 Terminal Avenue Clark, New Jersey
1	The Martin Company Attn: Chief, Manufacturing Res. & Development Laboratory Denver 1, Colorado	1	The Budd Company Defense Division 2450 Hunting Park Avenue Philadelphia 32, Pennsylvania Attn: Chief, Metallurgy Dept.
1	Crucible Steel Company Titanium Division Midland, Pennsylvania Attn: Dr. Walter L. Finley	1	Sciaky Brothers, Inc. 5915 W. 67th Street Chicago 38, Illinois Attn: Mr. W. J. Farrell, Chief Applications Engineer
2	Mallory Sharon Titanium Corporation Niles, Ohio Attn: Dr. L. S. McCoy Dr. L. S. Busch	1	Climax Molybdenum Company 1410 Woodrow Wilson Avenue Detroit 3, Michigan Attn: Mr. A. J. Herzig

DISTRIBUTION LIST (Continued)

- | | | | |
|---|--|---|---|
| 1 | Universal-Cyclops Steel Corporation
Refractomet Division
Bridgeville, Pennsylvania
Attn: Mr. C. Mueller, Mgr. | 1 | Lockheed Aircraft Corporation
Missile and Space Division
3251 Hanover Street
Palo Alto, California
Attn: Mr. R. A. Perkins
Metallurgist & Ceramic Res. |
| 1 | General Electric Company
Applied Research Operations
Flight Propulsion Laboratory Dept.
Cincinnati 15, Ohio
Attn: Mr. Louis P. Jahnke, Mgr.
Metallurgical Engineering | 1 | General Telephone and Electronics
Laboratories, Inc.
P. O. Box 59
Bayside, New York
Attn: Dr. L. L. Seigle, Mgr.
Metallurgical Lab. |
| 1 | General Electric Company
Missile and Ordnance Systems Dept.
3750 D Street
Philadelphia 24, Pennsylvania
Attn: Aerosciences Laboratory | 1 | National Aeronautics & Space Admin.
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio
Attn: Mr. Mervin Ault, Asst. Chief
Materials & Structures Div. |
| 1 | Boeing Airplane Company
P. O. Box 3707
Seattle 34, Washington
Attn: Mr. John T. Stacey, Senior
Group Engineer, Aerospace Div. | 1 | Boeing Airplane Company
P. O. Box 3996
Seattle 24, Washington
Attn: Mr. Edward G. Czarnecki
Chief Technical Staff
X-20 Branch |
| 2 | Republic Aviation Corporation
Farmingdale, Long Island, New York
Attn: Dr. S. Korman, Chief,
Materials Dev., R.A.C.
Attn: Mr. T. F. Imholtz,
Manufacturing Research | 1 | Fansteel Metallurgical Corporation
North Chicago, Illinois
Attn: Mr. Alan F. Busto, Technical
Administrator |
| 1 | Lockheed Aircraft Corporation
Burbank, California
Attn: Mr. E. Green, Mgr.,
Production Engineering Dept. | 1 | Massachusetts Institute of Technology
Cambridge 39, Massachusetts
Attn: Dr. Walter A. Backofen
Associate Prof. of Metallurgy |
| 1 | Lockheed Aircraft Corporation
Missiles and Space Division
Sunnyvale, California
Attn: Mr. Alfred Peterson, Mgr.,
Production Eng. Dept. 83-31 | 1 | Grumman Aircraft Engineering Corp.
Bethpage, Long Island, New York
Attn: Mr. Earl Morris, Materials
Engineering |
| 1 | Aerojet General Corporation
Solid Rocket Plant
Sacramento, California
Attn: Mr. Alan V. Levy
Head, Materials R&D Dept. (4610) | | |

DISTRIBUTION LIST (Concluded)

- 1 Commanding Officer
 Picatinny Arsenal
 Dover, New Jersey
 Attn: Mr. George Van Syckle
 Building 65, TAWC

- 1 Massachusetts Institute of Technology
 Department of Aeronautics and Astronautics
 Instrumentation Laboratory
 Cambridge 39, Massachusetts
 Attn: Miss Betty Robinson
 Ass't. Librarian

- 1 Delco Remy Division
 General Motors Corporation
 Anderson, Indiana
 Attn: Mr. J. R. West, Piress Dept.

- 1 Inspector of Naval Material
 10 North 8th Street
 Reading, Pennsylvania

- 1 Branson Instruments, Incorporated
 37 Brown House Road
 Stamford, Connecticut

- 1 P. R. Mallory and Company, Inc.
 Indianapolis 6, Indiana
 Attn: Mr. A. S. Doty, Director,
 Technical Services Laboratories